GAMETE SELECTION FOR UPRIGHT CARIOCA BEANS WITH RESISTANCE TO LEAFHOPPER AND FOUR DISEASES

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From its essentially unknown status 30 years ago, Carioca has become perhaps the most popular common bean (*Phaseolus vulgaris* L.) cultivar in Brazil. Among its desirable attributes include high seed yield, tolerance of low soil fertility, and resistance to bean common mosaic virus (BCMV) and anthracnose (ANT). But it is susceptible to water stress, common bacterial blight (CBB), bean golden mosaic virus (BGMV), leafhopper, bruchids, and fungal diseases such as angular leaf spot (ALS), rust, white mold, and web blight. Moreover, its weak stems and branches and indeterminate prostrate growth habit (type III) make it unsuitable for direct mechanical harvesting. Increasing demand for mechanization, and the need to reduce production costs and pesticide use necessitate the development of upright cultivars that are resistant to as large a number of diseases, pests, and other production constraints as possible.

Although, through two breeding cycles completed at CIAT, some progress has been made (Singh et al., 1992; Thung et al., 1993), combined resistance to water stress, various major diseases, leafhopper, and bruchids are not yet available in upright plant types. Our objective therefore was to develop upright Carioca beans with multiple resistances in the shortest time possible.

Breeding Method

A six-parent population, GX 9792 = EMP 250 //// A 769 /// A 429 / XAN 252 // V 8025 / Pinto UI 114, was developed. For the six-parent final cross, as well as for the intervening single, double, and five-parent crosses, plant-to-plant pair-wise pollinations were made between male and female parents. The pollinations would ensure adequate sampling of gametes from all parents involved. Thus, 460 F_1-derived F_2 ($F_{1:2}$) families were developed for the final population. All 460 $F_{1:2}$ families, parents, and susceptible and resistant checks to CBB and ALS were grown at CIAT-Quilichao. Plots were planted in a soil of moderately low fertility. Each plot consisted of a single row, 2 m long, without replication. The nursery was inoculated three times at weekly intervals with pathogens causing CBB and ALS, beginning 2 weeks after germination. Data on reactions to the diseases were taken, beginning 6 weeks after germination. All uniformly susceptible families to CBB and ALS were discarded. Resistant plants within selected families were harvested in bulk.

In F_3, seeds from selected families were divided into two groups. One group was grown at CIAT-Popayán, and inoculated three times, beginning 3 weeks after germination, with a mixture of pathogen isolates that cause ANT. The isolates were collected locally in previous cropping seasons.

The other group was grown at CIAT-Palmira under leafhopper pressure. All uniformly susceptible families for ANT and leafhopper were discarded. At Popayán, all ANT-resistant plants within each of 46 selected families that also possessed resistance to ALS and CBB (F_2), and leafhopper (F_3) were harvested in bulk. Subsequently, all non-Carioca type seeds within the selected families were discarded.

The F_4 was grown again at CIAT-Popayán under ANT pressure. Also, a similar F_4 nursey was grown under BGMV pressure in the greenhouse at CIAT-Palmira. A maximum number of upright plants with resistant or intermediate reaction to ANT and possessing Carioca seed characteristics in the 17 families also resistant to BGMV were harvested in bulk.

The F_5 was grown at CIAT-Palmira. Fifteen to twenty upright erect plants with Carioca seed types were harvested individually in each plot. These were grown in plant-to-progeny rows in F_6 at CIAT-Popayán under ANT pressure. All plants within plots uniform for flower color, growth habit, maturity, seed characters, and resistance to ANT were harvested in bulk and their seed increased in F_7 at CIAT-Quilichao and in F_8 at CIAT-Palmira. A separate nursery for each of BCMV, BGMV, leafhopper, CBB, and ANT was prepared to evaluate 260 $F_{5:9}$ lines, six parents, and eight checks.

Results

Only seven of the 260 $F_{5:9}$ lines were susceptible to BCMV and all others possessed the *I* gene for its resistance. Similarly, only 25 lines were susceptible to the mixture of ANT pathogen isolates from Popayán when inoculated in the seedling stage; 22 lines were intermediate, and 213 were resistant. For BGMV, 101 lines were resistant; 45 were intermediate; and 114 were susceptible. Only two lines were resistant to CBB, and 106 were intermediate. For leafhopper, no lines were resistant, but 69 lines were tolerant.

Table 1 summarizes the number of $F_{5:9}$ lines that possessed resistant, intermediate, or tolerant reactions to three (BCMV, CBB, and ANT) or more constraints. The number of F_1-derived F_2 families from which they originated is also shown. Four lines showed resistant or intermediate reaction to all five factors (Table 2). Similarly, 23 lines were resistant or intermediate to BCMV, CBB, ANT, and BGMV; and four lines were resistant or intermediate to BCMV, CBB, ANT, and leafhopper (data not shown).

Table 1. The number of $F_{5:9}$ lines of common bean with three or more resistances, and the number of F_1-derived F_2 families that contributed to them.

Resistance		Number of contributing $F_{1:2}$ families[a]	Number of $F_{5:9}$ lines
No.	Constraints		
5	BCMV CBB ANT BGMV LHP	3	4
4	BCMV, CBB, ANT, BGMV	6	23
4	BCMV CBB ANT LHP	3	4
3	BCMV CBB ANT	7	13

[a] BCMV = bean common mosaic virus CBB = common bacterial blight, ANT = anthracnose, BGMV = bean golden mosaic virus, and LHP = leafhopper

[b] The total number of unique $F_{1:2}$ families with resistance to three or more constraints was 10

Table 2. Four $F_{5:9}$ lines from the common bean population GX 9792 that possessed resistant (R) or intermediate (I) reaction to four diseases and leafhopper

Identification	Reaction to constraints[a]				
	BCMV	BGMV (% infection)	ANT	CBB	LHP
$F_{5:9}$ lines					
GX 9792-7-15	R	0	R	I	I
GX 9792-20-1	R	0	R	I	I
GX 9792-4-2	R	20	R	I	I
GX 9792-20-1	R	10	R	I	I
Checks					
A 247 (C1)	R	10	R	S	S
A 686 (C2)	R	30	S	I	S
Carioca	R	57	R	S	S

[a] BCMV = bean common mosaic virus BGMV = bean golden mosaic virus, ANT = anthracnose, CBB = common bacterial blight; and ALHP = leafhopper

References

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